# TELE-PATH INDUSTRIES
# LOOP TEST UNIT
# MODEL 90 $E_1$
# OPERATING MANUAL

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TELE-PATH INDUSTRIES, INC.

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# SECTION I

# INTRODUCTION

## 1.1 GENERAL INFORMATION

The DDS Loop Test Unit, Tele-Path Model 90 $E_1$, is designed to perform Bit and Block Error testing of the local four wire loop in digital data networks offering traditional high speed Digital Data Services (DDS) and recent Basic Digital Services to verify the presence of a good circuit from the serving office to the customer premises.

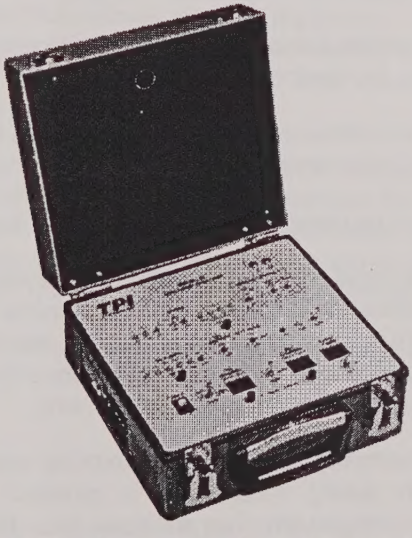



Figure 1-1. Top Cover Open View of the Loop Test Unit, Model 90 $E_1$

The Loop Test Unit's ability to generate a Bit and Byte clock also allows it to accomplish end to end Digital Testing on four wire circuit segments. The Loop Test Unit has the capability of testing both the Primary and Secondary Channels (where applicable) at data rates of 2.4, 4.8, 9.6, 19.2, 56, and 64 Kb/s.

### 1.1.1 DIGITAL NETWORK

Digital Data Networks are designed to provide highly reliable end-to-end digital service within the nation-wide telecommunications system. The first implementation of a digital network was not digital end-to-end, but had to make use of analog transmission systems for inter-city communications. Now, digital microwave radio and fiber optic transmission systems are available for long haul communications, making true end-to-end digital communications a reality.

There are two distinct advantages to transmitting data over a digital facility, as opposed to an analog facility:

1) Digital transmission is much less susceptible to noise, causing fewer errors.

2) Data can be transmitted at a much higher bit rate.

These two advantages are possible because transmission and reception of information in the digital format depends only on the detection of a pulse or no-pulse in a time slot, and does not look for variations in a sine wave to extract the information transmitted (as is the case in analog transmission).

Whether the customer chooses point-to-point service or multipoint, high quality transmission is provided and is safeguarded by stringent error rate and down-time objectives. Inherent with digital transmission systems such as DDS is the use of a highly accurate master timing supply to which an entire network is synchronized. Compatibility between networks must take into account the data format, timing signals, and the network control codes used in testing data facilities.

### 1.1.2 LOCAL LOOP

The DDS network, which is typical, can be engineered to meet individual customer needs, whether the customer is large or small. Typically, service consists of a digital facility that is terminated at each end by a local 4-wire loop. A Data Service Unit (DSU) and/or a Channel Service Unit (CSU) serves as the interface between the 4-wire local loop and the subscriber's Data Terminal Equipment (DTE). The DSU and CSU may be collocated in a single unit (referred to as a DSU), or they may be fabricated as separate pieces of equipment. In either case, the functions of the DSU/CSU remain the same. (The data sets, i.e. DSU/CSU, are referred to as Data Circuit-terminating Equipment, or DCE.)

On the central office end of the 4-wire local loop, an OCU (Office Channel Unit) serves as the interface between the loop and the channel bank equipment. The channel bank combines (via time division multiplexing) up to 24 voice and/or data channels into a single 1.544 Mbps bit stream (DS-1 format).

Figure 1-2 illustrates a typical digital network with local loops to customer terminals.

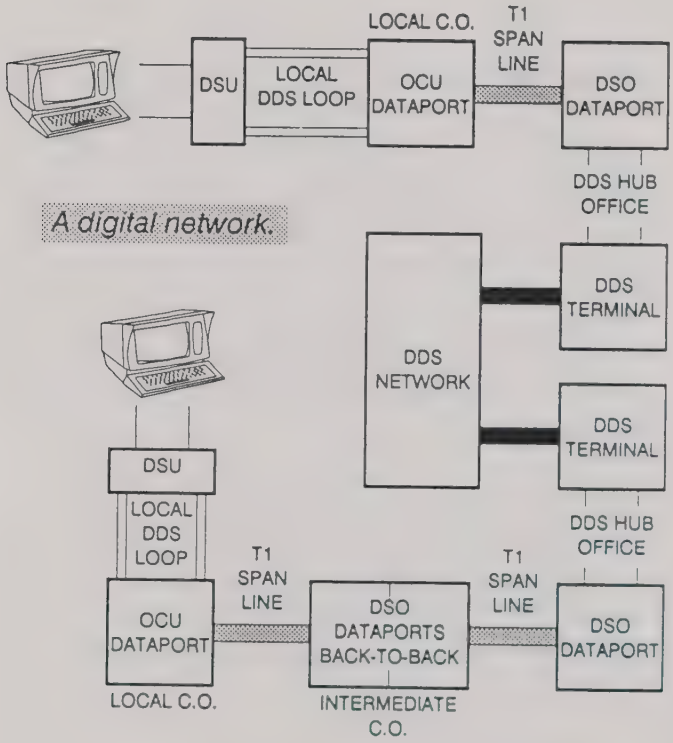



Figure 1-2

The signal format used to transmit data bits between the customer DTE and the DSU is Unipolar Pulses, while on the local loop the digital pulses are always Bipolar Return to Zero. The bit rate is customer optional to meet the rate requirements of their DTE. These "baseband" rates may be 2.4, 4.8, 9.6, 19.2, or 56 Kbps.

There are several advantages of using bipolar pulses:

1) Cuts frequency response time in half. This allows a higher bit rate on a cable pair, doubling the information that can be sent by using unipolar pulses.

2) Reduces the D.C. component on the local facility by alternating positive and negative pulses. D.C. voltages affect some loop tests.

3) As an error detector - two successive pulses of the same polarity means that an error has occurred. (called a "Bipolar Violation")

4) For control and supervisory codes - for example, the codes that are used to remotely initiate and release the loopback on the DSU make use of bipolar violations.

### 1.1.3 DATA SERVICE UNIT

The primary purpose of the DSU is to work in conjunction with the CSU to provide CPE access to the digital network. The DSU performs these functions:

1) Accepts unipolar pulses from the CPE, converts them to bipolar, and sends them to the CSU.

2) Accepts bipolar pulses from the CSU, converts them to unipolar, and sends them to the CPE.

3) Performs the RT (Remote Terminal) loopback feature that opens the transmit and receive leads to the CPE as it loops the transmit and receive leads back to the CSU (network). The RT loopback may be initiated locally at the DSU, or remotely.

### 1.1.4 CHANNEL SERVICE UNIT

The CSU performs three basic functions:

1) Accepts serial data in the bipolar format from the DSU and transmits it on the local loop to the serving central office.

2) Accepts serial, bipolar signals from the central office and transmits them to the DSU.

3) Provides a loopback feature. (Polarity of the simplex current controls the loopback function.)

### 1.1.5 OFFICE CHANNEL UNIT

The OCU (Office Channel Unit) performs 5 functions in serving as the link between the local loop and the serving central office:

1) Converts baseband data received from the local customer to the DSOA rate - 64 Kbps. The customer rate may be 2.4, 4.8, 9.6, 19.2, or 56 Kbps. Except for 56 Kbps, this conversion is accomplished through the process called "Byte Stuffing." For 56 Kbps, service, the DSOA signal is created by adding one network control bit, bit 8, to every seven bits of customer data. The result is a 64 Kbps signal.

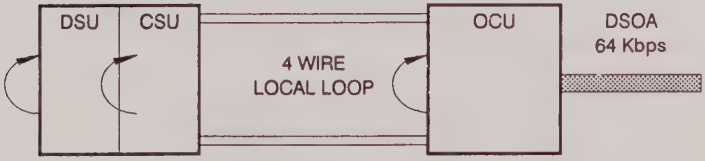
2) Decodes the 64 Kbps DSOA rate received from the network side and sends the proper rate to the local customer.

3) Performs line conditioning for the local loop (loss and bit speed conditioning).

4) Recognizes CSU loopback codes and performs the operations necessary to control the loopback functions.

5) Recognizes the OCU loopback code from the network side and places (or releases) the OCU in the loopback mode. The OCU loops back on the network side.

Access for performing digital tests on the OCU, local loop, and CSU/DSU is provided at the DSOA signal point. This access may be made by manually connecting a test set at the appropriate equipment location, or remotely through a SMAS (Switched Maintenance Access System) test point.




Curved arrows indicate where loopbacks are made.

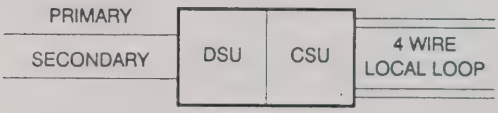
## 1.1.6 SECONDARY CHANNEL

OCU's, DSU's, and CSU's are available in the baseband rates 2.4, 4.8, 9.6, 19.2, and 56 Kbps. Recent offerings are also equipped for Secondary Channel transmission.

The Secondary Channel is a second transmission path, using the same facilities as primary transmission. Its purpose is to provide the customer with a channel over which network monitoring and diagnostic functions can be performed. The secondary channel operates at a much lower speed than the primary. For example, the secondary channel bandwidth available for 4.8 Kbps is 266.66 bps.

The secondary channel utilizes every third control bit for its transmission. On the local loop, secondary channel operation is accomplished by adding a leading bit (framing bit) and a trailing bit (control code and secondary channel data) to each 6 bits of primary channel data. In the 4.8 Kbps example, the local loop must be capable of transmitting at a 6.4 Kbps rate in order to handle the primary and secondary transmission.

SECONDARY CHANNEL OPERATION



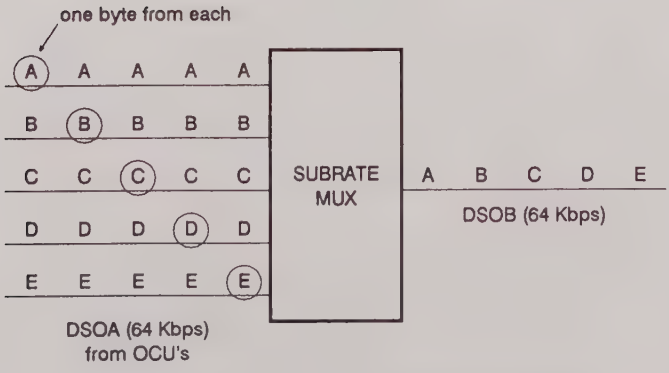

CHANNEL AND LOOP SPEED CALCULATIONS

| PRIMARY CHANNEL | SECONDARY CHANNEL | LOOP SPEED |
|---|---|---|
| 2400 | 133 1/3 | 3200 |
| 4800 | 266 2/3 | 6400 |
| 9600 | 533 1/3 | 12800 |
| 56000 | 2666 2/3 | 72000 |

## 1.1.7 DSOB SIGNALS

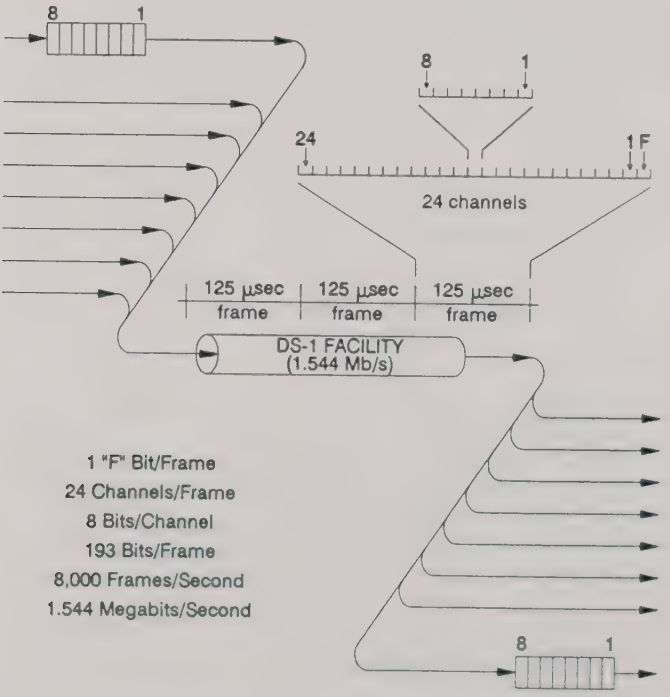
Within the telephone network, several subrate channels can be interleaved in the same 64 Kbps signal without loss of information by removing the redundancy in each DSOA signal. The resulting signal is called a "DSOB" signal. A single DSOB signal can carry up to five 9.6 Kbps customer channels, ten 4.8 Kbps channels, or twenty 2.4 Kbps channels. Unlike the DSOA signal, a fully utilized DSOB signal contains only a single copy of each network byte; successive network bytes contain data from different customers. A subrate framing pattern (shown below) is placed in the first bit position in order to allow the individual channels to be identified when the DSOB signal is demultiplexed.

| SPEED | PATTERN (bit 1) |
|---|---|
| 9.6 | 01100 |
| 4.8 | 01100 10100 |
| 2.4 | 01100 10100 11100 00100 |



### 1.1.8 DS-1

The next step in multiplexing is to combine, in channel bank equipment, the 64 Kbps signal with up to 23 other DSOB or DSOA signals to form a DS-1 formatted signal which runs at a bit rate of 1.544 Mb/s. This signal may then be transmitted on a T1 carrier facility, or multiplexed with other DS-1 signals to be transmitted on a facility capable of transmittiing at a higher bit rate. This facility might be digital microwave radio, coaxial cable, or light guide.




Data transmission through the network

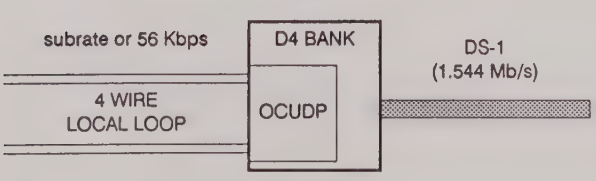
### 1.1.9 OCUDP

The alternative to converting the DSOA format to DSOB, before multiplexing to the 1.544 Mb/s rate, is the OCUDP. The customer baseband signal (2.4, 4.8, 9.6, 19.2, or 56 Kb/s) may be terminated in an OCU that is a part of the channel bank equipment. This type of OCU is referred to as an OCUDP, or Dataport Service. Byte stuffing occurs as in a standard OCU, but the DSOA signal is directly multiplexed into the DS-1 bit stream without going through the transformation to the DSOB format.

While this method does not provide us with the most efficient use of the facilities, it does give the customer virtually error free transmission through the network. This is possible because the receive end examines each bit pattern in the multiple copies of the bytes of the DSOA signal. Whatever bit pattern in the received bytes occurs the majority of times is taken as the actual customer transmission. The only way an error can be introduced in the bit stream is if the same errored bit is injected in the majority of the bytes that have been "stuffed." This process is referred to as "Majority-Vote" error correction.

For 56 Kbps service, the "Majority-Vote" error correction technique does not apply. Error correction can, however, be accomplished for 56 Kbps circuits by a different technique that employs two time slots on a DS-1 signal.

DATAPORT ARCHITECTURE



## 1.1.10 56 Kbps REPEATER

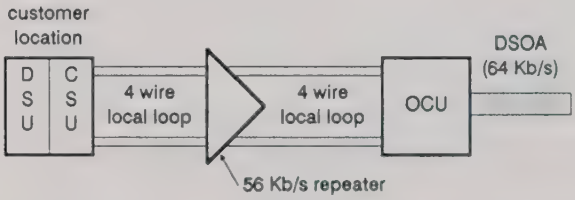
Since the transmission losses on 56 Kb/s local loops are much greater than for 2.4 - 19.2 Kb/s service, a 56 Kb/s regenerator must be used for long loops. Up to two 56 Kb/s regenerators may be used to extend a loop.

There are two types of 56 Kb/s regenerators:

1) central office

2) outside plant (manhole or pole mounted)

The 56 Kb/s regenerator is powered by simplex current fed from the OCU.




The regenerator may be looped back by sending the proper bipolar violation code to the OCU, which reverses the polarity of the simplex current. This is the same process that is used to loop back the CSU, so caution must be observed when you are testing on a loop that includes a 56 Kb/s regenerator.

In order to make metallic loop tests (DC continuity, noise, and loss) from the central office to the customer location, the 56 Kb/s regenerator(s) must be bypassed. A discrete bipolar violation sent to the OCU will cause the simplex current to be removed from the local loop, engaging the bypass feature in the regenerator.

## 1.1.11 EIA INTERFACES

The EIA interface is the multi-lead connection between the CPE and Data Service Unit (DSU). The Electronic Industries Association (EIA) defines the function of each of the interface leads. The functions fall into 4 major categories:

1) Mechanical

2) Electrical

3) Functional

4) Procedural

Covered are such items as physical size and shape of connectors, wire size, voltage levels, bit rates, control functions, and the sequence in which events occur across the interface.

The Model 90 $E_1$ Loop Test Unit is capable of operating with both the RS-232-C and the V.35 EIA interfaces. The unit replaces the DSU on the interface to the DTE.

The V.35 interface is used for 56 Kb/s service. The pins (leads) are designated A through Z with G, I, O, and Q omitted, and AA through MM, with GG and II omitted. The following chart lists the function of the leads in the V.35 EIA Interface.

| LEAD DESIGNATION | INTERFACE CONNECTOR PIN* | CCIT NUMBER* | FUNCTION |
|---|---|---|---|
| AA | A | 101 | protective ground |
| AB | B | 102 | signal ground |
| CA | C | 105 | request to send |
| CB | D | 106 | clear to send |
| CC | E | 107 | data set ready |
| CD | H | 108 | data terminal ready |
| DF | F | 109 | rcv. line signal detector |
| BA(B) | P | 103 | transmit data (balanced) |
| BA(A) | S | 103 | transmit data (balanced) |
| BB(A) | R | 104 | receive data (balanced) |
| BB(B) | T | 104 | receive data (balanced) |
| DD(A) | V | 115 | rcv sig element timing (balanced) |
| DD(B) | X | 115 | rcv sig element timing |
| DB(A) | Y | 114 | xmt sig element timing |
| DB(B) | AA | 114 | xmt sig element timing (balanced) |

* - Pin designation corresponds to CCIT V.35

The RS-232-C interface has 25 leads labeled 1 through 25, and is used with subrate digital service. An RS-232-C Primary Channel connector and a Secondary Channel interface connector are included on the Model 90 $E_1$ Loop Test Unit for testing this service.

The table below lists the interface lead definitions.

| PIN NUMBER | CIRCUIT | DESCRIPTION |
|---|---|---|
| 1 | AA | protective ground |
| 2 | BA | transmitted data |
| 3 | BB | received data |
| 4 | CA | request to send |
| 5 | CB | clear to send |
| 6 | CC | data set ready |
| 7 | AB | signal ground |
| 8 | CF | rcv line sig detector |
| 9 | – | (reserved for DSU testing) |
| 10 | – | (reserved for DSU testing) |
| 11 | | unassigned |
| 12 | SCF | sec rcv line sig detector |
| 13 | SCB | sec clear to send |
| 14 | SBA | sec transmitted data |
| 15 | DB | xmt sig element timing (DCE source) |
| 16 | SBB | sec received data |
| 17 | DD | rcv sig element timing |
| 18 | | unassigned |
| 19 | SCA | sec request to send |
| 20 | CD | data terminal ready |
| 21 | CG | sig quality detector |
| 22 | CE | ring detector |
| 23 | CH/CI | data sig rate selector (DTE/DCE source) |
| 24 | DA | xmt sig element timing |
| 25 | | unassigned |

## 1.2 PHYSICAL DESCRIPTION

The TPI Model 90 $E_1$ Loop Test Unit illustrated below consists of circuit boards and a power supply housed in an aluminum case. It weighs 9 3/4 pounds and has external dimensions of 6 1/2 inches high, 10 3/4 inches wide, and 10 1/4 inches deep.

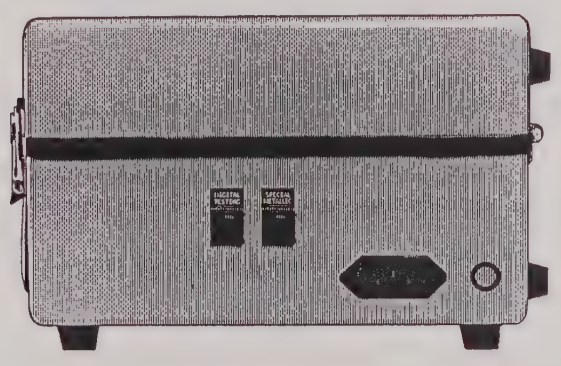
The power supply requirement is 105 to 129 volts at 50 to 70 Hertz and 26 Watts. It will operate satisfactorily over a temperature range of +40° to +120 °F and a relative humidity range of 20 to 95 percent.

An aluminum hinged cover attaches to the back of the unit to protect the control panel when the unit is being transported. The cover is secured by two front latches that snap loose and unhook.

A handle is attached to the front of the unit and is utilized to transport the Loop Test Unit $E_1$

## 1.2.1 EXTERNAL CONNECTIONS

All external connections to the Model 90 $E_1$ Loop Test Unit are made through jacks provided on the left and right sides of the case. The jacks on the right side of the case are for an 8-pin modular RJ-48 Telco jack ("DIGITAL TESTING"), a second Telco jack ("SPECIAL METALLIC") for metallic loop tests, the power cord connector, and a fuse holder.

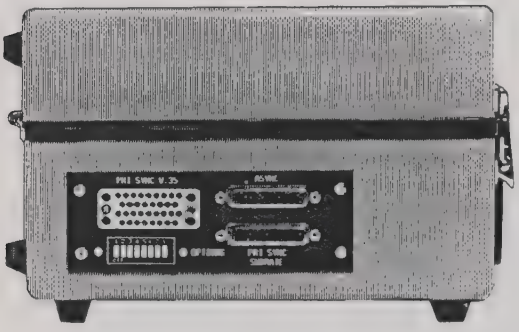


Most all testing will be done through connections to the "DIGITAL TESTING" modular jack.

The pin designations for the RJ-48 Telco interface are as follows:

| PIN NUMBER | FUNCTION | PIN NUMBER | FUNCTION |
|---|---|---|---|
| 1 | R1 | 5 | NOT USED |
| 2 | T1 | 6 | NOT USED |
| 3 | NOT USED | 7 | T |
| 4 | NOT USED | 8 | R |

The left side of the case houses the connectors for EIA interface (connections to the DTE), and the "OPTIONS" switch.



There are three connectors:

1) a V.35 Primary Channel synchronous 56 Kb/s female connector

2) an RS-232 Primary Channel synchronous subrate female connector

3) an RS-232 Secondary Channel asynchronous female connector

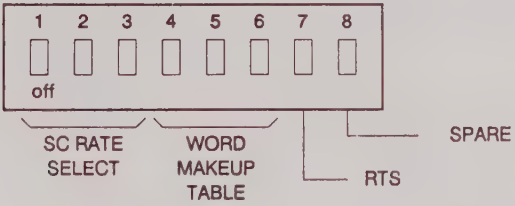
The "OPTIONS" switch is provided for:

1) Secondary Channel bit rate selections for Primary Channel rates

2) asynchronous word make-up on the Secondary Channel

3) operating mode options

This switch should be set with all positions "ON" for normal operation.




OPTION SWITCH

| PRIMARY RATE SELECTED (KBPS) | ASYNCHRONOUS SECONDARY CHANNEL RATE (bps) | SWITCH POSITION (1) | (2) | (3) |
|---|---|---|---|---|
| 2.4 | 75 | ON | ON | ON |
| 4.8 | 75 | ON | ON | ON |
| | 150 | OFF | ON | ON |
| 9.6 | 75 | ON | ON | ON |
| | 150 | OFF | ON | ON |
| | 300 | OFF | OFF | ON |
| 19.2 | 75 | ON | ON | ON |
| | 150 | OFF | ON | ON |
| | 300 | OFF | OFF | ON |
| 56 | 150 | ON | ON | ON |
| | 300 | ON | OFF | ON |
| | 1200 | OFF | OFF | ON |
| 56* SCRAMBLE | 300 | ON | ON | ON |
| | 1200 | ON | OFF | ON |
| | 2400 | OFF | OFF | OFF |

Asynchronous Secondary Channel Rate Settings

*Point-to-point only

The Loop Test Unit $E_1$ is capable of testing with any of the possible choices in the make-up of the asynchronous word, as given in the table below:

| ASYNCHRONOUS WORD MAKE-UP | SWITCH POSITION 4 | SWITCH POSITION 5 | SWITCH POSITION 6 |
|---|---|---|---|
| 8 BITS, 1 STOP BIT, NO PARITY | ON | ON | ON |
| 8 BITS, 2 STOP BITS, NO PARITY | ON | ON | OFF |
| 8 BITS, 1 STOP BIT, PARITY | ON | OFF | ON |
| NOT USED | ON | OFF | OFF |
| 7 BITS, 2 STOP BITS, NO PARITY | OFF | ON | ON |
| 7 BITS, 1 STOP BIT, PARITY | OFF | ON | OFF |
| 7 BITS, 2 STOP BITS, PARITY | OFF | OFF | ON |
| 6 BITS, 2 STOP BITS, PARITY | OFF | OFF | OFF |

Asynchronous word make-up

## NOTE:

*Since the Loop Test Unit $E_1$ does not actually perform parity checking, it doesn't matter whether parity is even or odd. It is, however, important to know if the extra bit is present or not.*

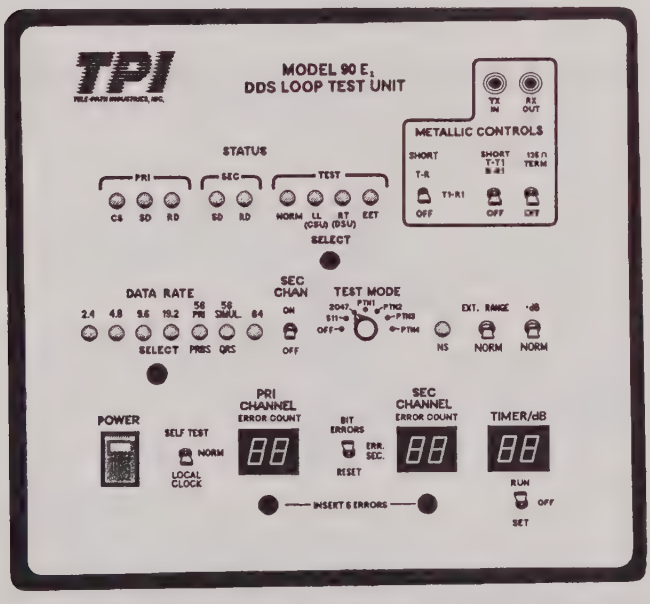
Position 7 of the "OPTIONS" switch allows you to turn the Request to Send (RTS) lead permanently ON:

| FUNCTION | SWITCH POSITION 7 |
|---|---|
| RTS PERMANENTLY ON | ON |
| RTS CONTROLLED | OFF |

TABLE 1-3. Operating Modes

## 1.2.2 CONTROLS AND INDICATORS

The control panel contains switches to condition the unit, light-emitting diodes (LED's) as status indicators and as counters, and metallic controls.




A description of the controls, indicators, and counters is given below:

Primary Channel Indicators

CS(Clear to Send) - Illuminates when primary DTE is clear-to-send.

SD(Send Data) - Illuminates when primary data is being transmitted.

RD(Receive Data) - Illuminates when primary data is being received.

Secondary Channel Indicators

SD(Send Data) - Illuminates when secondary data is being transmitted.

RD(Receive Data) - Illuminates when secondary data is being received.

Test Indicators

NORM - Illuminates when the unit is in a normal CSU/DSU mode, i.e., not LL, RT, or EET.

LL(CSU) - Illuminates when the unit is in local line loopback.

RT(DSU) - Illuminates when the unit is in remote terminal loopback.

EET - Illuminates when an end-to-end test is being conducted and is failing.

TEST Select

The TEST Select Pushbutton allows selection of the Test Modes described in the above Test Indicators paragraph, i.e. manual loopback testing. It is a pushbutton activated, LED indicating, step function device. Depressing the pushbutton selects the next successive test/function.

## METALLIC TESTING Aids

| | | |
|---|---|---|
| TX IN<br>RX OUT | - | Mini-bantam jacks provided to allow access to the Transmit and Receive pairs for external test equipment [i.e., Tone Generator, Level Meters, etc.] |
| SHORT(T-R,T1-R1) | - | A three position switch that shorts either the T & R or the T1 & R1 conductors of the cable pairs to aid in loop resistance tests. |
| SHORT(T-T1/R-R1) | - | A two position switch that shorts the transmit and receive cable pairs simultaneously to aid in metallic testing. |
| 135 OHM TERM. | - | A two position switch which places a 135 Ohm termination on the transmit and receive pairs for noise testing. |

## DATA RATE Select

The DATA RATE Switch is a pushbutton activated, LED indicating, step function device. Depressing the pushbutton selects the next highest data rate available.

## SEC CHANNEL Switch

This two position switch enables Secondary Channel operation. If the circuit is not optioned for Secondary Channel, this switch must be in the "OFF" position. If the circuit is configured for Secondary Channel operation, this switch must be in the "ON" position.

## TEST MODE Switch

This seven position rotary switch determines whether the unit is functioning as a normal CSU/DSU (OFF), or is testing via industry standard 511/2047 PRBS and QRS (Pseudo-Random Bit Sequence and Quasi-Random Signal), or any of four Pattern Sensitive Sequences (valid only in the Primary Channel).

The following table shows what is transmitted in which channel. This will also depend on the data rate selection.

| TEST MODE switch position | Data Rate (Kb/s) | Pri. Chan. Transmission | [1]Sec. Chan. Transmission |
|---|---|---|---|
| OFF | Any | Cust. Data | Cust. Data |
| 511 or 2047 | 2.4 - 19.2 | PRBS | PRBS |
| 511 or 2047 | 56 PRI | PRBS | Idle (all 1's) |
| 511 or 2047 | 56 SIMUL | [2] QRS/PRBS | PRBS |
| 511 or 2047 | 64 | [3] PRBS | N/A |
| PTN1 - PTN4 | 2.4 -19.2, 56PRI | Ptn. Sen. | Idle (all 1's) |
| PTN1 - PTN4 | 64 | [3] Ptn. Sen. | N/A |

[1] The SEC CHAN switch must be "ON".

[2] If the Secondary Channel is enabled, QRS is transmitted. Otherwise, PRBS is transmitted. QRS is a form of PRBS that has been altered to transmit no more than six 0's into the network.

[3] May cause excessive 0's to be transmitted. For use with circuits configured with zero substitution (e.g. B8ZS) only.

Please note that if there is no test data being transmitted on a particular channel (i.e. customer data or idle code is being transmitted), the error counter for that channel will blank.

NS Indicator

This red LED extinguishes when access is gained to the local loop. In Primary Channel operation, this LED will illuminate when loss of line signal is detected, and will flash when receiving some network control codes, e.g. Abnormal Station Code (S0011110).

EXT. RANGE Switch

With this switch in the "NORM" position, the Loop Test Unit will function on circuits with up to – 34 dB of loss (approx.). With this switch in the "EXT. RANGE" position, the Loop Test Unit will function on circuits with up to – 48 dB of loss (approx.) at the 56Kbps data rate. A marginal circuit might test good in "EXT. RANGE", but not in "NORM".

– dB Switch

This two position switch allows the test technician to place additional loss/stress on the Local Loop. The worst case result is approximately –3dB of additional loss on both transmit and receive. The intent of this feature is to allow the Local Loop to be tested with an increment of degradation amounting to less than 10%.

POWER Switch

A rocker switch that illuminates an LED in the ON position.

CONFIGURATION Switch

This three position switch (SELF TEST position is momentary) allows the unit to be configured in a SELF TEST or LOCAL CLOCK mode, when enabled.

The SELF TEST mode results in the Transmit (T-T1) and Receive (R-R1) cable pairs being shorted, and allows the unit to be checked for proper operation.

The LOCAL CLOCK mode is utilized for end-to-end testing between two Loop Test Units on point-to-point four wire loops. The LOCAL CLOCK position would be enabled on the unit designated master, which would provide clock for the other unit with the CONFIGURATION Switch set to NORMAL.

PRI CHANNEL ERROR COUNT Display

This two digit LED Display counts either Bit errors or Block errors (errored seconds) in the Primary Channel, depending on the position of the ERROR COUNT Switch. If the two digit capacity is exceeded, a period/decimal point will be illuminated. This display will illuminate only when the unit is in a primary channel test mode (please refer to table on page 1-24).

BIT ERRORS/ERRORED SECONDS Switch

A three position (RESET position is momentary) toggle switch used to select the error counting mode, or reset the error counters.

SEC CHANNEL ERROR COUNT Display

This two digit LED Display that counts Bit errors or Block errors (errored seconds) in the Secondary Channel, depending on the position of the ERROR COUNT Switch. If the two digit capacity is exceeded, a period/decimal point will be illuminated. The display will illuminate only when the SEC. CHAN. Switch is in the "ON" position, and the unit is in a secondary channel test mode (please refer to table on page 1-24).

TIMER/dB

When a timed test is being conducted, this two digit display shows the time selected/remaining. Otherwise, it shows the amount of loss on the local loop, or "77" if the amount of loss is out of range.

To conduct a timed test, increment the counter in one minute intervals by moving the switch toward the "SET" position. When the desired amount of time is reached, movement of the switch to the "RUN" position will start the timed test. A period/decimal point will be illuminated to indicate a timed test in progress. At timeout, both ERROR COUNT Displays will lock the results and a second period/decimal point will be illuminated (.0.0). To resume untimed operation, the switch MUST be moved back to the OFF position.

**NOTE:**

*When time out has occurred as noted by ".0.0" in the display, the unit is in a locked condition and will function only after moving the "TIMER" switch to "OFF".*

INSERT SIX ERRORS

These pushbuttons, located under the PRIMARY and SECONDARY ERROR COUNT Displays, allow insertion of six bit errors on their respective channels.

## 1.2.3 CABLES AND ACCESSORIES

The Model 90E1 DDS Loop Test Unit comes equipped with the following cables and accessories:

| | |
|---|---|
| TPI 90E-1 (TPI 834013) | Power Cord |
| TPI 90E-2 (TPI 834005) | 8-Pin MOD to 8-Pin MOD Cable |
| TPI 90E-3 (TPI 835965) | 8-Pin MOD to Clip Leads Cable |

The Model 90E$_1$ DDS Loop Test Unit has several optional features and accessories which may be ordered as well:

| | |
|---|---|
| TPI 32 (TPI 837203) | Soft Pack Carry Case |
| TPI 31 (TPI 837202) | Transit Case |
| TPI 90E-4 (TPI 834035) | 8-Pin MOD to Clip Leads Cable (HD) |
| TPI 90E-5 (TPI 835880) | Battery Power Option |
| TPI 90E-6 (TPI 825157) | Battery Pack |
| TPI 90E-7 (TPI 851700) | Deep Charge Battery Charger |
| TPI 90-56 (TPI 835972) | SW-56 Call Set-Up Unit |

## 1.3 FUNCTIONAL DESCRIPTION

### 1.3.1 APPLICATION

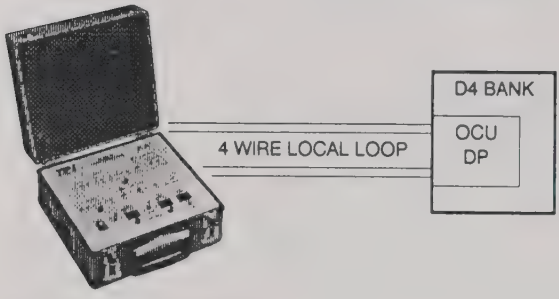
The DDS Loop Test Unit, TPI Model 90 $E_1$, is used to verify the presence of a good circuit from the customer premise to the serving central office. Its testing capabilities support data rates of 2.4, 4.8, 9.6, 19.2, 56, and 64 Kb/s (plus the corresponding rate for secondary channel capable circuits). The Loop Test Unit has CSU/DSU functionality, can transmit and receive 511/2047 Pseudo-Random Bit Sequences (PRBS), 511/2047 Quasi-Random Signals (QRS), or any of the four pattern-sensitive sequences in the Primary Channel (511 or 2047 Pseudo-Random Bit Sequences in the Secondary Channel), and indicates bit or block errors on each channel. It is compatible with industry standards, including the ability to test both the Primary and Secondary Channels simultaneously at all data rates. The Loop Test Unit's ability to generate a Bit and Byte clock also allows it to accomplish end-to-end Digital Testing on four wire circuit segments. Additionally, controls are provided for assistance in metallic testing.

Typical testing applications include:

Local Loop, four wire DDS

STRAIGHTAWAY - DDS LTU to Network-Primary & Secondary Channel
- Network to DDS LTU-Primary & Secondary Channel

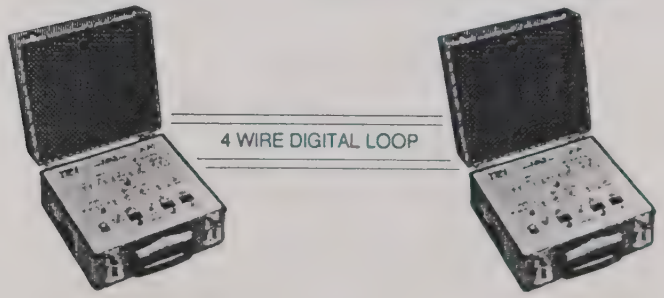
LOOPBACK - Network to DDS LTU-Primary & Secondary Channel




Four wire Digital Circuit

STRAIGHTAWAY - DDS LTU to DDS LTU

LOOPBACK - DDS LTU to DDS LTU Looped



## 1.3.2 SELF TEST

The Loop Test Unit $E_1$ has a built-in Self Test feature. When the CONFIGURATION Switch (lower left) is moved to the SELF TEST position and held, the Receive section is internally connected to the Transmit section in both Primary and Secondary Channels. To check for proper operation, the TEST MODE switch should be moved to 511 or 2047 position. Any data rate may be selected. Following a momentary transition, reset the counters and monitor to verify that they remain at "00". Errors may be injected for additional test confidence. Other Data Rates can also be selected to assure proper operation. The SECONDARY CHANNEL Selection Switch will control as normal.

A more extensive Self Test may be performed by first connecting the TELCO jack labeled "DIGITAL TESTING" to the TELCO jack labeled "SPECIAL METALLIC" using the cable that has modular plugs on both ends. Put the Configuration switch to the "LOCAL CLOCK" position, put the TEST MODE switch to either "511" or "2047", and activate the Metallic Testing switch that is labeled "SHORT T-T1 R-R1." This will accomplish everything that the previously described Self Test procedure does, but will also test the DTE interface and the cable.

Another Self Test procedure may be performed in a similar fashion to the second Self Test, but with the TEST MODE switch set to "OFF" and the CONFIGURATION switch set to "LOCAL CLOCK", using a Bit Error Rate Test (BERT) device connected to the DTE interface on the left side of the Loop Test Unit. This procedure tests the unit's internal CSU/DSU circuitry, the cable being used, and also the DTE interface connections.

### 1.3.3 MAINTENANCE

The only replaceable parts on the Loop Test Unit are the line fuse and the external cords. The LED indicators and displays are soldered into the unit and are not field replaceable.

## 1.4 SPECIFICATIONS

TEST CAPABILITY

PRIMARY CHANNEL

XMT/RCV 511 OR 2047 PSEUDORANDOM WORDS
XMT/RCV 511 OR 2047 QRS AT 56 KB/S DATA RATE
XMT/RCV FOUR PATTERN SENSITIVE SEQUENCES
DISPLAY BIT ERRORS
DISPLAY ERRORED SECONDS

SECONDARY CHANNEL (SIMULTANEOUS WITH PRIMARY)

XMT 511 OR 2047 PSEUDORANDOM WORDS
RCV 511 OR 2047 PSEUDORANDOM WORDS
DISPLAY BIT ERRORS
DISPLAY ERRORED SECONDS

SELF TEST

LOCAL CLOCK/TEST GENERATION

EXTENDED RANGE/NORMAL RANGE SELECTION

–3 dB PLACEMENT

dB READOUT (+/– 3 dB)

NETWORK CODE COMPATIBILITY

DSU LOOPBACK

CSU LOOPBACK

CSU LATCHING LOOPBACK

DSU LATCHING LOOPBACK

DATA RATES SUPPORTED

2.4, 4.8, 9.6, 19.2, 56, AND 64 Kbps

CONTROLS

DATA RATE

SECONDARY CHANNEL

TEST MODE (511, 2047, 4 PTN SENSITIVE SEQUENCES)

–3 dB PLACEMENT

EXTENDED RANGE/NORMAL RANGE SELECTION

POWER

SELF TEST/LOCAL CLOCK

BIT ERRORS/ERRORED SECONDS

SET TIMER

TEST

- NORM
- LL (CSU)
- RT (DSU)
- EET

METALLIC AIDS

- SHORT
- 135 OHM TERMINATE
- TX, RX JACKS

LINE INTERFACE

8 PIN MODULAR RJ-48 JACK (4 WIRE FULL DUPLEX)

DTE INTERFACE

SUB-RATE OPERATIONS: RS-232

56 AND 64 Kbps OPERATION: V.35

SEC CHANNEL OPERATIONS: RS-232

INDICATORS

PRIMARY CHANNEL

CS = CLEAR TO SEND
SD = SEND DATA
RD = RECEIVE DATA

SECONDARY CHANNEL

SD = SEND DATA
RD = RECEIVE DATA

TEST

NORM = NON LL/RT/EET MODE
LL = LOCAL LINE LOOPBACK
RT = REMOTE TERMINAL LOOPBACK
EET = END-TO-END TEST (FAILURE)

POWER LED

PRI CHANNEL ERROR DISPLAY

SEC CHANNEL ERROR DISPLAY

TIMER/dB DISPLAY

NS = NO SIGNAL LED

POWER REQUIREMENTS

110 VAC INPUT

ENVIRONMENTAL

OPERATING TEMP = 0°C to 50°C

STORAGE TEMP = -20°C to 70°C

PHYSICAL

PORTABLE W/ HINGED LID

6 1/2"H x 10 3/4"W x 10 1/4"D

9 3/4 lbs.

# SECTION II

# USING THE MODEL 90 $E_1$ LOOP TEST UNIT

## 2.1 TEST INFORMATION

The procedures described herein relate to testing of the four wire digital loop from the telephone company to the customer interface. DDS and Basic Digital Service are two examples of services that utilize digital local loops.

### 2.1.1 LOOP TEST UNIT SET-UP

Open the top cover on the Loop Test Unit by unsnapping and unlatching the two latches.

Insert the POWER cable into the side connector provided on the Loop Test Unit. Connect the other end of the grounded POWER cable to a 120 VAC power source. Move the POWER rocker switch on the control panel to the ON position. Verify that the POWER switch LED is lit, as well as a DATA RATE LED and the TIMER/dB display. If not, then

1) Check the fuse.

2) Conduct the SELF TEST procedure (Refer to paragraph 1.3.2) to determine if the Loop Test Unit is operational.

On power-up, the TIMER/dB display will attempt to show the amount of loss on the circuit. If the Loop Test Unit $E_1$ is not connected to the local loop, it will show "77". If connection has been made, but the front panel settings are incorrect for the circuit, the display will be unpredictable. Other LED's may be lit, depending on the position of various switches.

There are two cord sets provided for the network (TELCO) interface. One is a seven foot cable with 8-pin modular plugs at both ends. The other is a seven foot cable with an 8-pin modular plug at one end and color-coded alligator clips at the other end.

Below is a description of the color code:

| | | | |
|---|---|---|---|
| T | White | R | Red |
| T1 | Black | R1 | Yellow |

This table also appears on a label attached to this cord set.

The Loop Test Unit $E_1$ has two 8-pin modular receptacles. The one labeled "DIGITAL TESTING" will be used for all test procedures except when access is desired for Metallic Test Assistance. The other 8-pin modular jack, also located on the right side of the Loop Test Unit $E_1$, is labeled "SPECIAL METALLIC" and allows the four wires to be accessed, shorted, or terminated for assistance in Metallic Test Procedures.

Utilizing the appropriate cable for your application, connect the 8-pin modular plug to the 8-pin modular jack labeled "DIGITAL TESTING" on the right side of the Loop Test Unit $E_1$, and connect the other end to the TELCO interface.

The "NS" LED (No Signal) should not be illuminated (unless the network is transmitting all 0's). If it is illuminated, check the T, R, T1, & R1 connections.

All switches should be in the "NORMAL" or "OFF" position. The SECONDARY CHANNEL switch should be in the "ON" position ONLY if the circuit is optioned for Secondary Channel operation. Also, the "OPTIONS" switch, located on the left side of the unit, should have all switches set in the "ON" position for normal operation.

Connectors are provided on the left side of the Loop Test Unit for DTE interface, where needed. These include Primary Channel subrate (RS-232-C), and 56 Kbps (V.35) synchronous connectors, and a Secondary Channel (RS-232-C) asynchronous connector. The options switch is utilized to configure the Secondary Channel asynchronous interface.

## 2.1.2 TEST ACCESS

Network access for Digital Testing must be gained via one of the two TELCO interface cables. Once accomplished, the Loop Test Unit $E_1$ is ready to be used to verify the presence of a good circuit from the serving central office to the demarcation point at the customer premise.

## 2.1.3 TYPES OF TESTS

The DDS Loop Test Unit $E_1$ has the capability to conduct simultaneous testing in the Primary and Secondary Channels using 511 or 2047 Pseudo-Random Bit Sequences (PRBS). At the 56 Kb/s data rate, the 511 or 2047 Quasi-Random Signal (QRS) is used in the Primary Channel, as per industry standards regarding simultaneous testing. Any of four pattern-sensitive sequences (see table below) may be used in the Primary Channel. Bit or block errors on both Primary and Secondary Channels are displayed.

| TEST | CONTENTS |
|---|---|
| PTN1 | 100 octets of all 1's, followed by 100 octets of all 0's |
| PTN2 | 100 octets of "01111110", and 100 octets of all 0's |
| PTN3 | 01001100 continuously repeated |
| PTN4 | 01000000 continuously repeated |

The Loop Test Unit $E_1$ is compatible with embedded network test equipment and allows straightaway testing with the 511 and 2047 Pseudo-Random Bit Sequences in both channels, or pattern sensitive sequences in the primary channel. Bit errors in groups of six can be inserted into the transmitted test data in either channel.

The Loop Test Unit $E_1$ is equipped with CSU and DSU loopback controls and indicators, as well as CSU and DSU latching loopback capability (DSU LLB in Sec. Chan. circuits only). Also, the Loop Test Unit $E_1$ is equipped with features to assist in metallic testing.

## NOTES:

*If the circuit being tested is configured for secondary channel operation, the secondary channel switch must be in the "ON" position; the configuration of the unit must reflect the configuration of the circuit.*

*The Pattern Sensitive Sequences (PTN 1 through PTN 4) apply to Primary Channel testing only. The Secondary Channel Error Count Display will blank when any of these test patterns is selected.*

*The 56 PRI data rate selection is used for testing only the Primary Channel of a 56 Kb/s circuit. Idle (all 1's) is transmitted in the Secondary Channel.*

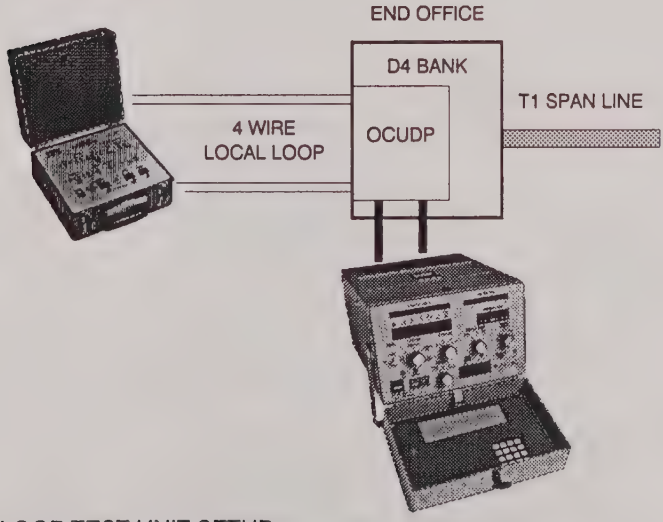
*To test the Secondary Channel of a 56 Kb/s circuit, select 56 SIMUL. data rate and either 511 or 2047 test mode. This will test both channels simultaneously. Please note that this data rate selection is not valid for Pattern Sensitive testing; the 56 PRI selection is used.*

## 2.2 TYPICAL APPLICATIONS

### 2.2.1 STRAIGHTAWAY TESTING, FOUR WIRE LOCAL LOOP

Straightaway Testing can be accomplished when access to a circuit is gained at two different points, e.g., the end of the local loop at the customer premise and at some point in the network. The Loop Test Unit $E_1$ and the Network Test Equipment can each transmit, or transmit and receive simultaneously, a known test pattern toward the other. The data received by each is analyzed.

TYPICAL CIRCUIT




LOOP TEST UNIT SETUP

Set up the cords as per Paragraph 2.1.1.

SWITCH SETUP ( Loop Test Unit $E_1$)

## NOTE:

*All switches should be set to the NORMAL or OFF position, unless indicated otherwise below:*

| | | |
|---|---|---|
| TEST MODE switch | - | 511 or 2047 for simultaneous Primary and Secondary Channel testing, or any of the pattern sensitive sequences |
| ERRORS switch | - | Bit or Block |
| DATA RATE selector | - | Rate on Subscriber card |
| POWER switch | - | On |
| SEC CHANNEL switch | - | Should be "ON" ONLY if the circuit is optioned for Sec. Chan. Operation. Otherwise, this switch MUST remain in the "OFF" position. |

## NOTES:

*If the SEC CHANNEL switch is set to "OFF", the secondary channel error count display will blank.*

*The pattern sensitive sequences apply to primary channel testing only; idle code will be transmitted in the secondary channel, and the secondary channel error count display will blank.*

## PROCEDURE FOR PRIMARY CHANNEL TESTING

**NOTE:**

*This example refers to cooperative testing with TPI's Data Test Unit Model 108/109 RT II as the Network Data Test Unit at the near end OCUDP (setup must be consistent with the Loop Test Unit's setup).*

ACTION - Connect the Data Test Unit Signal and Clock leads to a D4 Channel Bank via the appropriate OCU Dataport Card and timing source, and initiate the proper testing sequence (511, 2047, or pattern sensitive).

RESPONSE - The PRIMARY CHANNEL ERROR COUNTER on the Loop Test Unit and the ERROR COUNTER on the Data Test Unit should lock. Reset both counters. They should hold at zero.

ACTION - Errors may be inserted in either direction. For example, depress the "INSERT 6 ERRORS" Pushbutton on the Loop Test Unit once.

RESPONSE - The Network Data Test Unit's error count will display 6 bit errors.

ACTION - Depress the "ALL 1's" Pushbutton on the Network Data Test Unit.

RESPONSE - The Loop Test Unit's ERROR COUNT display will indicate errors.

## PROCEDURE FOR SECONDARY CHANNEL TESTING

**NOTE:**

*The procedure for secondary channel testing is only applicable to circuits that are optioned for secondary channel operation.*

ACTION - Set up the Network Data Test Unit for Secondary Channel, 511 or 2047 Transmit & Receive Testing (e.g. KEYPAD 5, 3, 1).

RESPONSE - The Loop Test Unit's SECONDARY CHANNEL ERROR COUNTER will lock and the Network Data Test Unit Keypad display will indicate zero S.C. errors and zero Block errors. Reset the Loop Test Unit's ERROR COUNTERS.

ACTION - Errors may be inserted in either direction. For example, depress the Loop Test Unit's "INSERT 6 ERRORS" Pushbutton once.

RESPONSE - The Network Data Test Unit's Keypad Display will indicate 6 S.C. errors and typically 1 Block error.

ACTION - Change a switch setting on the Network Data Test Unit, e.g., temporarily move the INPUT/OUTPUT switch.

RESPONSE - The Loop Test Unit's SECONDARY CHANNEL ERROR COUNT will display errors.

## NOTES:

*If the circuit being tested is configured for secondary channel operation, the secondary channel switch must be in the "ON" position; the configuration of the Loop Test Unit $E_1$ must reflect the configuration of the circuit.*

*Recent versions of TPI's 108/109 RT II Data Test Unit allow both channels to be tested simultaneously with either 511 or 2047.*

*The Pattern Sensitive Sequences (PTN 1 through PTN 4) apply to Primary Channel testing only. The Secondary Channel Error Count Display will blank when any of these test patterns is selected.*

*The 56 PRI data rate selection is used for testing only the Primary Channel of a 56 Kb/s circuit. Idle (all 1's) is transmitted in the Secondary Channel.*

*To test the Secondary Channel of a 56 Kb/s circuit, select 56 SIMUL. data rate and either 511 or 2047 test mode. This will test both channels simultaneously. Please note that this data rate selection is not valid for Pattern Sensitive testing; the 56 PRI selection is used.*

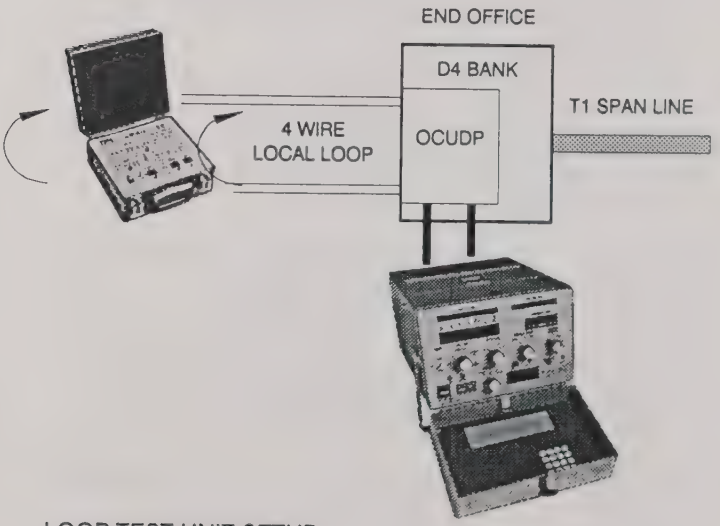
## 2.2.2 LOOPBACK TO NETWORK

**NOTE:**

*DSU latching loopback capability is available only with circuits optioned for Secondary Channel operation.*

The Loop Test Unit $E_1$ has the capability to establish local (CSU) and remote (DSU) Loopbacks to allow Network Test Equipment to perform Loopback confidence testing on the four wire local loop.

TYPICAL CIRCUIT




LOOP TEST UNIT SETUP

Set up the cords per Paragraph 2.1.1.

SWITCH SETUP

## NOTE:

*All switches should be set to the NORMAL or OFF position, unless indicated otherwise below:*

| | | |
|---|---|---|
| DATA RATE selector | - | Rate on Subscriber card |
| ERROR switch | - | Bit Errors or Errored Seconds |
| POWER switch | - | On |
| SEC CHANNEL switch | - | Should be "ON" ONLY if the circuit is optioned for Sec. Chan. Operation. Otherwise, this switch MUST remain in the "OFF" position. |

## NOTES:

*If the circuit being tested is configured for secondary channel operation, the secondary channel switch must be in the "ON" position; the configuration of the Loop Test Unit $E_1$ must reflect the configuration of the circuit.*

*Since the TEST MODE switch is in the "OFF" position, there is no test being conducted by the Loop Test Unit $E_1$; it is only providing a loopback toward the Network Test Equipment. As a result, both error counters will blank on the Loop Test Unit $E_1$.*

PROCEDURE

ACTION - Initiate a CSU Loopback Test from the Network Data Test Unit.

RESPONSE - On the Loop Test Unit $E_1$, the "LL" LED will illuminate, to indicate a successful CSU (LL) Loopback. On the Network Data Test Unit, the counter should lock and allow either Bit or Block Error Testing to be accomplished.

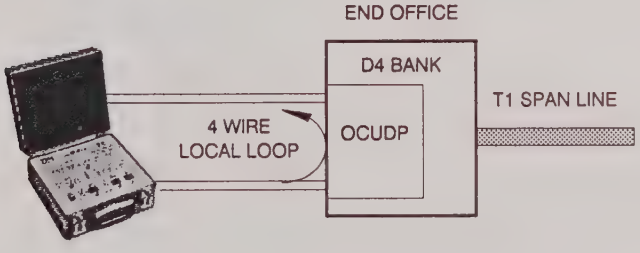
ACTION - Initiate a DSU Loopback from the Network Test Unit.

RESPONSE - On the Loop Test Unit $E_1$, the "RT" LED will illuminate, to indicate a successful DSU (RT) Loopback. On the Network Data Test Unit, the counter should lock and allow either Bit or Block Error Testing to be accomplished.

## 2.2.3 LOOPBACK TO LOCAL LOOP

The Loop Test Unit $E_1$ can conduct either Bit Error or Block Error (Errored Second) testing on the Local Loop when a hard loop is placed on the OCU Dataport Card. These tests can be accomplished on Secondary Channel optioned circuits or on Primary Channel only circuits.

TYPICAL CIRCUIT




LOOP TEST UNIT SETUP

Set up the cords per Paragraph 2.1.1.

SWITCH SETUP

## NOTE:

*All switches should be set to the NORMAL or OFF position, unless indicated otherwise below:*

| | | |
|---|---|---|
| DATA RATE selector | - | Rate on Subscriber card |
| TEST MODE switch | - | 511 or 2047 for simultaneous Primary and Secondary Channel testing, or any of the pattern sensitive sequences |
| ERROR switch | - | Bit Errors or Errored Seconds |
| POWER switch | - | On |
| SEC CHANNEL switch | - | Should be "ON" ONLY if the circuit is optioned for Sec. Chan. Operation. Otherwise, this switch MUST remain in the "OFF" position. |

## NOTES:

*If the circuit being tested is configured for secondary channel operation, the secondary channel switch must be in the "ON" position; the configuration of the Loop Test Unit $E_1$ must reflect the configuration of the circuit.*

*If the SEC CHANNEL switch is set to "OFF", the secondary channel error count display will blank.*

## NOTES: (continued)

*The Pattern Sensitive Sequences (PTN 1 through PTN 4) apply to Primary Channel testing only. The Secondary Channel Error Count Display will blank when any of these test patterns is selected.*

*The 56 PRI data rate selection is used for testing only the Primary Channel of a 56 Kb/s circuit. Idle (all 1's) is transmitted in the Secondary Channel.*

*To test the Secondary Channel of a 56 Kb/s circuit, select 56 SIMUL. data rate and either 511 or 2047 test mode. This will test both channels simultaneously. Please note that this data rate selection is not valid for Pattern Sensitive testing; the 56 PRI selection is used.*

PROCEDURE

ACTION - Verify that a hard loop has been placed on the OCU Dataport card.

RESPONSE - The PRIMARY CHANNEL ERROR COUNT on the Loop Test Unit will lock. Reset the counter and it should read and hold "00".

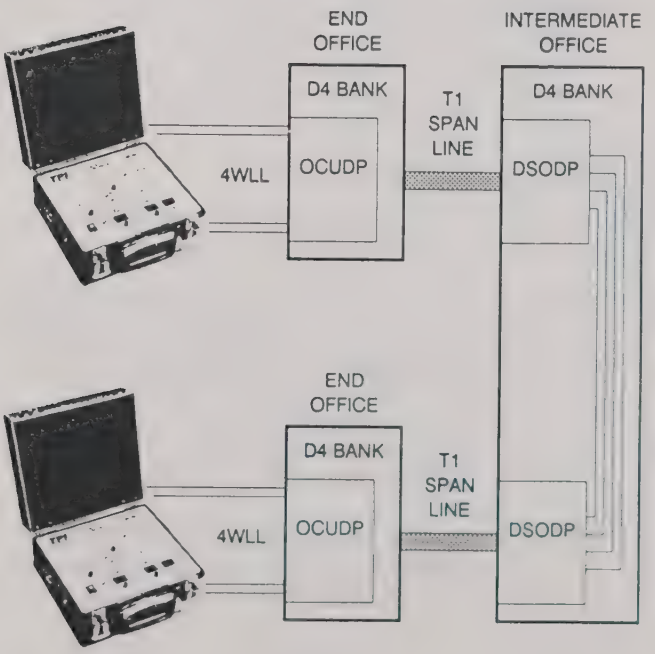
ACTION - Errors may be inserted. Depress the "INSERT 6 ERRORS" Pushbutton on the Loop Test Unit.

RESPONSE - The Loop Test Unit's PRIMARY CHANNEL ERROR COUNT Display will indicate 6 Bit errors, or typically one Block error.

## 2.2.4 END TO END TESTING—NETWORK

The Loop Test Unit $E_1$ has the capability to accomplish Bit Error or Block Error (Errored Second) cooperative testing (customer premise to customer premise). These tests can be conducted on Secondary Channel optioned circuits or Primary Channel only circuits. These end-to-end tests require the use of two DDS LTU's. Both straightaway and manual loopback type testing can be conducted.

TYPICAL CIRCUIT



LOOP TEST UNIT SETUP-Manual Loopback

## NOTE:

*All switches should be set to the NORMAL or OFF position, unless indicated otherwise below:*

| | | |
|---|---|---|
| DATA RATE switch | - | Rate on Subscriber card |
| TEST MODE switch | - | 511 or 2047 for simultaneous Primary and Secondary Channel testing, or any of the pattern sensitive sequences |
| ERROR switch | - | Bit Errors or Errored Seconds |
| POWER switch | - | On |
| SEC CHANNEL switch | - | Should be "ON" ONLY if the circuit is optioned for Sec. Chan. Operation. Otherwise, this switch MUST remain in the "OFF" position. |

## NOTES:

*If the circuit being tested is configured for secondary channel operation, the secondary channel switch must be in the "ON" position; the configuration of the Loop Test Unit $E_1$ must reflect the configuration of the circuit.*

*If the SEC CHANNEL switch is set to "OFF", the secondary channel error count display will blank.*

## NOTES: (continued)

*The Pattern Sensitive Sequences (PTN 1 through PTN 4) apply to Primary Channel testing only. The Secondary Channel Error Count Display will blank when any of these test patterns is selected.*

*The 56 PRI data rate selection is used for testing only the Primary Channel of a 56 Kb/s circuit. Idle (all 1's) is transmitted in the Secondary Channel.*

*To test the Secondary Channel of a 56 Kb/s circuit, select 56 SIMUL. data rate and either 511 or 2047 test mode. This will test both channels simultaneously. Please note that this data rate selection is not valid for Pattern Sensitive testing; the 56 PRI selection is used.*

PROCEDURE

The Loop Test Unit $E_1$ may be used in a cooperative manner with another Loop Test Unit $E_1$ at another customer premise in a Straightaway Test, similar to the Paragraph 2.2.1 procedure, except that network test equipment is not involved. Counters should lock, be resetable, and hold "00" on both units.

In order to use the Loop Test Units in a manual Loopback Test, the following steps would be followed:

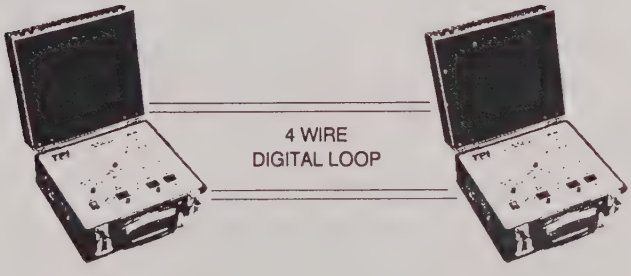
ACTION - Select the "LL" Local Line Mode on one of the Loop Test Units. (call it "Control")

RESPONSE - This will provide a loop toward the other Loop Test Unit (call it "Test"), causing its PRIMARY CHANNEL ERROR COUNT Display to lock. Reset the counters. Errors may be inserted from the "Test" unit

## 2.2.5 END TO END TESTING, FOUR WIRE DIGITAL LOOP

The Loop Test Unit $E_1$ also has the capability to accomplish Bit Error or Block Error (Errored Second) cooperative testing from one customer premise to another customer premise, without a network between the two customer premises. These tests can be conducted in a similar fashion to paragraph 2.2.4, also requiring the use of two Loop Test Units.

TYPICAL CIRCUIT



LOOP TEST UNIT SETUP-Manual Loopback

## NOTE:

*All switches should be set to the NORMAL or OFF position, unless indicated otherwise below:*

| | | |
|---|---|---|
| DATA RATE switch | - | Circuit rate |
| ERROR switch | - | Bit Errors or Errored Seconds |
| CONFIGURATION switch | - | Local Clock (control unit) |
| POWER switch | - | On |
| SEC CHANNEL switch | - | Should be "ON" ONLY if the circuit is optioned for Sec. Chan. Operation. Otherwise, this switch MUST remain in the "OFF" position. |

## NOTES:

*If the circuit being tested is configured for secondary channel operation, the secondary channel switch must be in the "ON" position; the configuration of the Loop Test Unit $E_1$ must reflect the configuration of the circuit.*

*If the SEC CHANNEL switch is set to "OFF", the secondary channel error count display will blank.*

*The Pattern Sensitive Sequences (PTN 1 through PTN 4) apply to Primary Channel testing only. The Secondary Channel Error Count Display will blank when any of these test patterns is selected.*

*The 56 PRI data rate selection is used for testing only the Primary Channel of a 56 Kb/s circuit. Idle (all 1's) is transmitted in the Secondary Channel.*

*To test the Secondary Channel of a 56 Kb/s circuit, select 56 SIMUL. data rate and either 511 or 2047 test mode. This will test both channels simultaneously. Please note that this data rate selection is not valid for Pattern Sensitive testing; the 56 PRI selection is used.*

PROCEDURE

The Loop Test Unit may be used in a cooperative manner with another Loop Test Unit at another customer premise in a Straightaway Test similar to the paragraph 2.2.1 procedure. In this case, the TEST MODE switch can be set to 511, 2047, or any of the pattern sensitive sequences on both units.

The Loop Test Units may also be used in a pass/fail manual loopback test, similar to the paragraph 2.2.4 procedure. In this case, the TEST MODE switch is set to NORM on both units, and the TEST Select button on the "control" unit would be used to select "EET", with the test selected on the "test" unit being "NORMAL". Upon initiating the test, the "EET" LED on the "control" unit will illuminate, then extinguish (If it doesn't extinguish, the test fails). The "RT" LED will flash on the "test" unit.

## NOTES:

*The manual END-TO-END Test is pass/fail, and no actual error count is produced. If an error count is desired, please refer to the previous END-TO-END Testing procedure.*

*Since no error count is produced from this procedure, both of the error count displays will blank.*

## 2.3 TIMED TEST

Any one of the tests discussed can be a timed test by utilizing the EVENT TIMER on the Loop Test Unit $E_1$.

PROCEDURE

ACTION - Move the toggle switch to the SET position.

RESPONSE - The TIMER/dB display will show the timer's current setting.
- The TIMER/dB display will increment in one minute intervals for each movement of the toggle switch to the SET position.

ACTION - Move the toggle switch to the RUN position when the desired time is set.

RESPONSE - A period/decimal point will be illuminated with the time set on the TIMER/dB Display. At timeout, a second period/decimal point will be illuminated, and the display will again show the dB loss (i.e., ".X.X", where the X's represent the loss). Additionally, both ERROR COUNT displays will lock at timeout.

**NOTE**

*If the switch is left in the RUN position with the time selected, and a timed test has concluded, two decimals will appear in the TIMER/dB display. The Loop Test Unit $E_1$ will not function until the TIMER/dB switch is moved to either the OFF position or the SET position.*

## 2.4 METALLIC TESTING AIDS

If the 8-Pin Modular TELCO Jack marked Metallic is utilized, the following Aids may be used in conducting Metallic Testing:

- A toggle switch on the Loop Test Unit may be used to short the cable pairs either T to R or T1 to R1.
- A toggle switch on the Loop Test Unit may be used to short Transmit & Receive cable pairs, shorting T to T1 and R to R1 simultaneously.
- A toggle switch on the Loop Test Unit may be used to place a 135 Ω termination on the Transmit & Receive cable pairs.
- Two mini-bantam jacks on the Loop Test Unit may be used for Transmit and Receive Metallic access.
- T, R, T1, and R1are identified by color code on the universal interface cord.

## 2.5 TROUBLESHOOTING

| PROBLEM | SOLUTION |
|---|---|
| Displays will not light | - TEST selector is in either "LL" or "RT" loopback mode. This condition may have been initiated manually, or by the network.<br>- For either error count display to light, the TEST MODE must be set to 511, 2047, or one of the pattern sensitive sequences.<br>- Neither of the Error Count Displays will light if the TEST MODE switch is set to any of the Pattern Sensitive Sequences and the DATA RATE selector is set for 56 Kb/s Simultaneous testing. Set the DATA RATE selector to 56 PRI if you wish to conduct Pattern Sensitive testing at the 56 Kb/s data rate.<br>- For the Secondary Channel error count display to light, the TEST MODE must be set to either 511 or 2047; the pattern sensitive sequences apply to primary channel testing only. |

| PROBLEM | SOLUTION |
|---|---|
| "NS" LED is lit | - Indicates "no signal", or all 0's being received. Check the cord connections.<br>- The network may be transmitting all 0's if there is nothing connected to the network side of the OCU. (If there is nothing connected to the OCU, the data that it will transmit on the local loop will vary with the OCU's manufacturer. |
| "NS" LED is flashing | - Network is transmitting control codes; may also indicate that there is nothing connected to the network side of the OCU. |
| Two decimal points are lit on the TIMER/dB display, and the error counters are locked up | - A timed test was conducted, and has terminated. Please refer to section 2.3. |
| TIMER/dB display shows "77" | - The Loop Test Unit $E_1$ is attempting to measure the loss on the local loop, but the amount of loss is too great for this measurement be displayed (overflow). |

# SECTION III

# BATTERY POWER OPTION

## 3.1 GENERAL DESCRIPTION

The optional battery pack for the Loop Test Unit family of products is used where access to 120 VAC is not available.

The battery pack is located inside the hinged lid of the unit; connnection is made through a cord which is located in the upper right corner of the control panel.

There is a battery charging circuit that is internal to the unit; the battery pack will automatically be charged whenever the unit is plugged in. However, it is strongly recommended that the TPI 90E-7 Battery Charger be used periodically to enhance the lifespan of the battery pack.

## 3.2 BATTERY REMOVAL

Open the vinyl cord storage cover located in unit's lid.

Disconnect the battery pack from the unit by unplugging the connector.

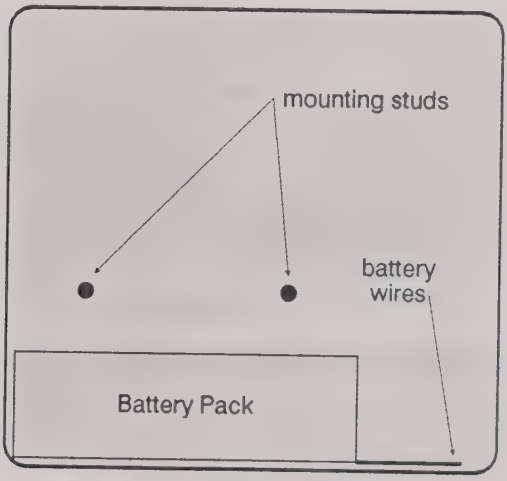
Remove the two knurled nuts that hold the battery mounting bracket in place, and remove the mounting bracket.

The battery pack may now be removed.

## 3.3 BATTERY INSTALLATION

Open the vinyl cord storage cover located in unit's lid.

Position the battery pack as shown in the diagram below, with the battery in the lower left cornerof the lid, with the wires and connector on the lower right corner of the battery pack




Inside of Loop Test Unit lid,
with battery mounting bracket removed.

Put the battery mounting bracket over the studs in the lid. Push down (toward the battery pack) and fasten the two knurled nuts.

Connect the battery wires to the unit.

## 3.4 OPERATION

A unit with the optional battery pack is used the same as the standard unit. All procedures for testing and control still apply.

When the unit is plugged in, it will operate using 120 VAC, and when it detects the lack of this power source it will automatically switch over to battery power. Whenever the unit is connected to a 120 VAC, it will automatically charge the battery pack.

There are, however, some important points to keep in mind:

- The life of the battery pack is approximately 4 hours.
- When the "LOW BATTERY" LED lights, you have approximately 10 minutes of operating time. After this time period, results will be erratic.
- Periodic use of the TPI 90E-7 Battery Charger is strongly recommended. This will serve to enhance the lifespan of the battery pack through deep-cycle charging.

## 3.5 USING THE TPI 90E-7 BATTERY CHARGER

The TPI 90E-7 Battery Charger is periodically used to restore the battery pack to its original capacity. The cycle involved is rather time-consuming; it is recommended that a battery pack is left on the TPI 90E-7 Battery Charger overnight.

If you need to use the unit while the battery pack is connected to the TPI 90E-7 Battery Charger, you will need to install a second battery pack, TPI 90-6 (TPI 825157) while the first one is charging. Please refer to the previous paragraphs for battery removal and installation. Connect the first battery pack to the TPI 90E-7 Battery Charger, and press the "START" button. An indicator LED on the TPI 90E-7 Battery Charger will light when the charging cycle has been completed.

If you do not need to use the unit during the charging cycle, you do not need to remove the battery pack. Open the vinyl cord storage cover located in the lid, disconnect the battery pack from the unit, and connect the battery pack to the TPI 90E-7 Battery Charger. Press the "START" button on the TPI 90E-7 Battery Charger. An indicator LED on the TPI 90E-7 Battery Charger will light when the charging cycle has been completed.

## 3.6 SPECIFICATIONS

| | |
|---|---|
| Battery life | - Approx. 4 hours |
| Battery life after "BATTERY LOW" LED lights | - Approx. 10 minutes |
| Charger | - The unit contains an internal charging circuit.<br>- Periodic use of TPI 90E-7 Battery Charger is highly recommended to enhance battery lifespan. |

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